Wireless Transmission Technique for Monitoring and Controlling of Power Equipments Using Public GSM Network

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Abstract: - It helps greatly to monitor electric power equipments in real time for malfunctions diagnosis. Traditionally, industrially applied wire transmission media to transmit the remote monitoring data. However, due to the wide distributed of power equipments, poor flexibility and questionable stability will raise by using wire configuration. Hence, this research designed a wireless real time monitoring system by using power monitor chip with conversion components to get the data including three-phase power voltage, electric current, electric frequency and electric power. Apply GSM mobile module to send the SMS containing the controlling code to the controlled ends of the system, which would automatically send back to the transmitter feedbacks of information including all of the data that been monitored. The use of wireless SMS scheme makes the monitoring commands and information observation not confined to a fixed point, enhancing the monitoring flexibility, convenience and reliability.

Key-Words: - Wireless Transmission, Power Equipments Monitoring, Global System of Mobile Communication, Short Message Service, Microprocessor.

1 Introduction

The normal functioning of electric power equipment such as power transformers has important impact on the productivity of the manufacturer. Therefore, it helps greatly to monitor those electric power equipments in real time for malfunctions diagnosis. Also, the operation parameter for the relevant electric power devices can be used for analysis and judgment to prevent or pre-alarm the faulty situation. Traditionally, industrially applied cable transmission models such as RS485, TCP/IP, and MOBUS transmit the remote monitoring data. With respect to production facilities or equipment automation, the cable transmission models, in cases of the controlled ends located in remote areas or distributed widely, will raise the system cabling cost and the system configuration cost dramatically in addition to difficult maintenance. Moreover, as cabling is requested, the monitoring end needs to be fixed at a given point resulting in poor flexibility and questionable stability.

Moreover, the electric power meters monitoring in the country are mostly conducted manually or by PC. However, the higher construction and configuration costs for the network monitoring system deter small enterprises and individuals to use and purchase by high price and complex equipment wiring. Therefore, if we can send by Global System of Mobile communication (GSM) mobile module message the codes to the electric power monitoring facilities to get real time monitoring data, not only the current way of transmission by PC can be replaced but also raises the mobility in addition to same functions. We are able to conduct fastest and most accurate monitoring on the electric power contents at far ends anywhere, substantially increasing the convenience and mobility.

On the basis of the highly developed mobile communications era today [1], it is believed that the wireless transmission platform may modify and improve the cable transmission disadvantages. The present day GSM network system has been established to a perfect level leading to the popular use of mobile phones [2]. And GSM network can have reliable Short Message Service (SMS) to transmit data in addition to voice [3]. There already have many applications that apply the advantage of GSM network to improve the conventional uses [4-9]. Hence, this research designed a wireless real time monitoring feedback system to connect the built-in GSM module in the mobile phone to GSM network, making it possible to send back the monitoring data without material cabling between the monitored ends. The use of SMS makes the monitoring commands and information observation not confined to a fixed point, enhancing the monitoring flexibility, convenience and reliability. Therefore, this research applied SMS in collecting electric power data to further achieve the monitoring purpose, and developed a set of GSM remote monitoring equipment that mainly monitor the relevant electric data at the monitored ends including the three-phase voltage rms value, electric current, electric power and electric frequency. In addition, information on the statuses of power source over voltage, under voltage, over current and power status are fed back to the far-located monitoring end by SMS.

Also, this research used SAMES Company's SA9904b chip [9] with conversion components such as current transformer and Hall Effect components to get the data including three-phase power voltage, electric current, electric frequency and electric power. Apply GSM mobile module to send the message containing the controlling code to the controlled ends of the system, which would automatically send back to the transmitter feedbacks of information including all of the data that been monitored.

2 System Structure

This section is to elaborate on the system structure and the design procedures of relevant hardware and software. The system structure is as shown in Fig. 1. Install the GSM remote monitoring device developed in this research at the monitored station. The device collects the information on electric voltage and current with its power calculated. And the monitoring data collected can be sent from the GSM modules at the monitored end to the GSM module of the far monitoring end by GSM network system.

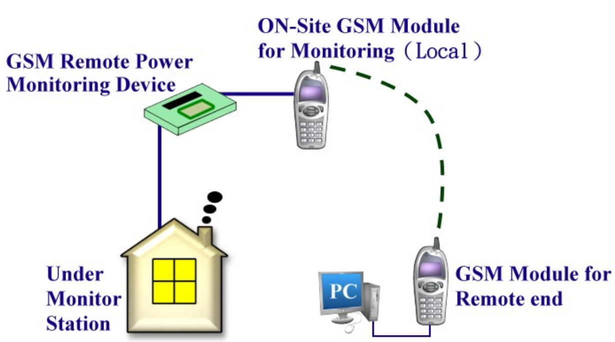

Fig. 1 GSM remote monitoring system structure

2.1 Hardware Circuits

The GSM remote monitoring device developed in this research is mainly for the monitored station signal collection and information transmission. The main circuit diagram of this device is as shown in Fig. 2 including mainly circuits such as voltage collection circuit, current collection circuit, power calculation circuit, power supply circuit, LCD circuit and RS232 circuit. The major micro controlling unit (CPU) is AT89C52 manufactured by ATMEL.

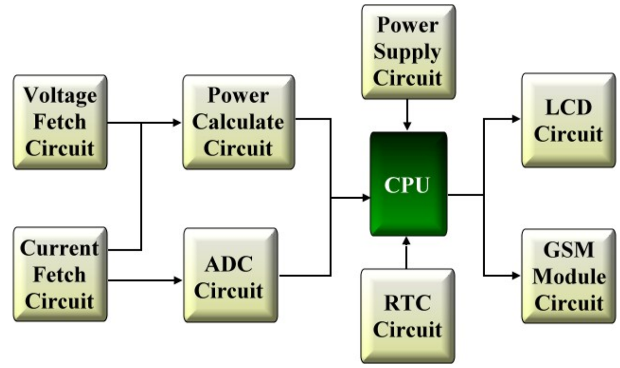

Fig. 2 System circuit diagram

The electric voltage circuit, the electric current circuit and power calculation circuit are mainly to collect the signals of the three-phase electric voltage and current of the monitored end and to work out the power by SA9904B [9]. SAMES SA9904B is designed to measure active power, reactive power, the rms values of voltage/power and the integrated three-phase power. The internal diagram of SA9904B is shown as in Fig. 3. It includes the SPI serial interface communicating with the micro controlling unit, two sets of ADCs for sampling voltage and current, reference benchmark unit, vibrator, frequency calculation, active power and reactive power calculation units etc. The active power and reactive power, voltage, current and frequency measured at various phases can be obtained from the internal 24-digit memory by SPI interface. The zero crossing point of the voltage and current can be obtained at the output of F50.

The voltage measuring is achieved mainly by resistor voltage sharing while the current measuring is achieved mainly by applying CT serially connected with the monitored end to covert the current signals to voltage signals for inputting the measured signals into SA9904B for relevant electric data calculations. The electric diagram is as shown in Fig. 4.

As SA9904B lacks the current output signal, a circuit should be designed to make it up. The circuit can be divided into two parts: one part is to collect the current signals and convert them properly; the other is to covert the analogous signals into digital signals for the micro controller to read. Fig. 5 shows the current signal collection and conversion circuits, in which the current signals are collected by CT and converted by the full-wave rectifying and amplifying circuits consisted of OP to DC signals, making the circuit output and current rms values in certain proportion; then, apply ADC0809 shown in Fig. 6 to convert the signals into digital ones to get the current data.

The system includes a 6*2 LCM screen display at the monitored end to serve as the output interface. Fig. 7 shows the electric circuit, which is mainly for displaying real time monitoring data in the monitored stations. The LCM is a 16*2 character type LCM with HD44780 as its driving control chip. CPU sets the internal related memories of HD44780 to make it possible for the LCM to display correctly related electric power data.

Fig. 8 shows the RS232 interface circuit. After collecting the monitoring data, this system transmits the data to GSM system by the GSM module circuit while the far monitoring end can get relevant monitoring data by SMS. CPU applies the AT COMMAND under RS232 communication protocol to control the GSM module to send out SMS. MAX232 shown in Fig. 8 is the standard conversion IC, by which CPU makes it in conformity with RS232 electric standards to establish the communications platform with the GSM module.

2.2 Software Procedure

Fig. 9 shows the software main procedure: first, execute CPU, LCD and related peripherals initializations; read out in order the various phases' rms voltages, frequencies, and powers inside SA9904B and store the data in the internal memories according to SPI protocol; check there is any feedback command at the far end; control the GSM module and write the monitoring data into SMS to be sent back the far monitoring end if there is any feedback command; if not, check whether there is any abnormality such as over voltage, under voltage and over current among the monitoring data; automatically report to the far end any abnormality; if not, check whether it is time to automatically feedback; send back information if it is the feedback time; if not, read new monitoring data afresh. The communication format of SMS [10-11] sent by far end GSM module to the monitored end is shown as table 1.

Table 1. The communication format of SMS sent by far end GSM module to the monitored end

Pass code	Command code	End code

The pass code column is to prevent wrong actions of the system arising from advertisement interference in the monitoring end and the monitored end. The command code is to set or control the execution of relevant actions by the monitored end. The end code represents the end control command. The format of SMS sent by the monitored end to the far monitoring end is as shown below in table 2 [10-11].

The pass code and end code of this column is the same as the aforementioned while the abnormality codes represent various abnormal statuses such as over voltage, over current. And the other columns are relevant information on electric power parameters.

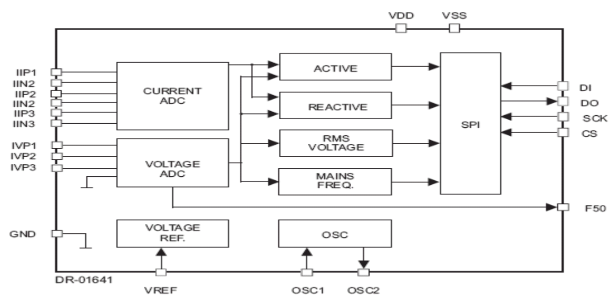

Fig. 3 SA9904b internal diagram

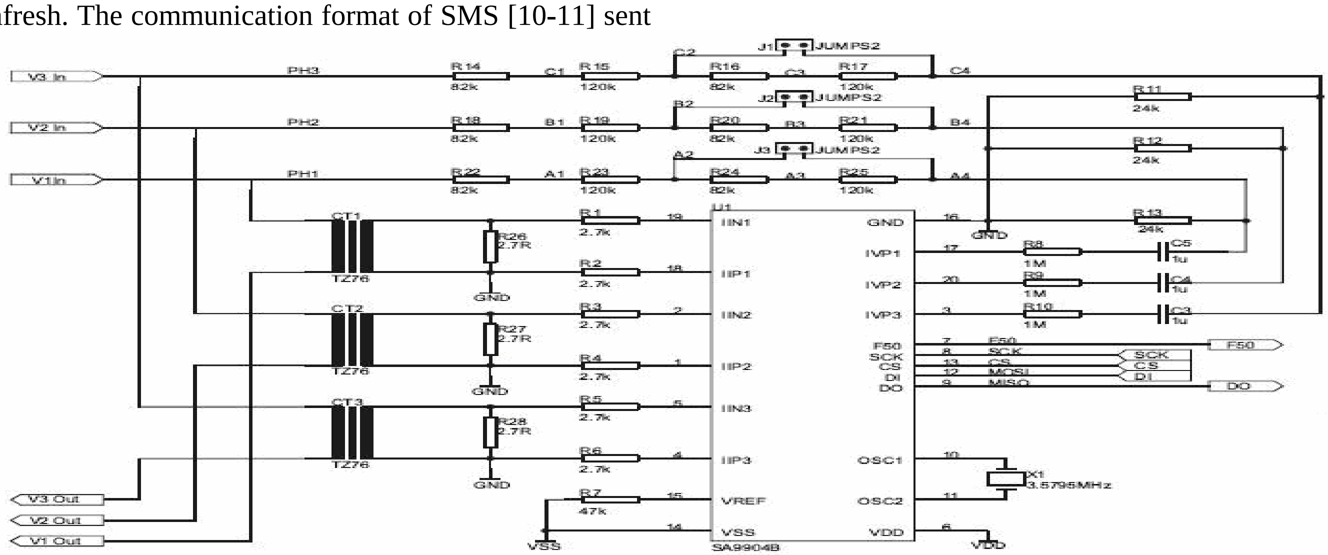

Fig. 4 Voltage, current and power calculation circuit

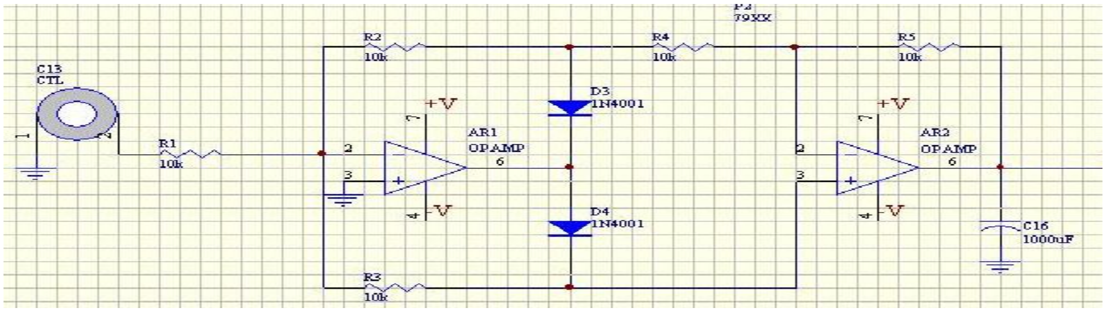

Fig. 5 Current collection circuit

Table 2. The format of SMS sent by the monitored end to the far monitoring end

Pass code	Abnormality code	Voltage	Current	Power	Frequency	End code

3 System Functions and Test Methods

System functions and test methods can be mainly divided into four parts as illustrated below:

1. Instantaneous feedback of monitoring data.

Transmit SMS to the monitored station and command it to feedback the monitoring data Instantaneous.

2. Voltage abnormality feedback

The system input voltage is taken from the power supply through self-coupling transformer. Therefore, adjusting the self-coupling transformer can simulate the utility power supply variations. When the input voltage is more or less than 10% of the normal level, the device automatically feeds back the abnormality to the monitoring end.

3. Current abnormality feedback

Install three-phase alterable loads at the monitored end and adjust the loads to make the current go beyond the preset protecting level for simulating the over current status. In case of over current, the device automatically sends back the abnormality message to the monitoring end.

4. Wait for sending back monitoring data in cycle.

By making use of the timepiece function of the built-in microchip inside the GSM remote monitoring device, this device can automatically record the time with preset cycle of 10 minutes. Therefore, the device feedbacks the monitoring data to the monitoring end every 10 minutes.

Fig. 10 and 11 demonstrate the electric voltage, frequency, active power and reactive power displayed on the LCD of the GSM remote monitoring device.

4 Conclusion

The development of wireless communications has been improving and enhancing the remote monitoring technology. It is an important link of the remote monitoring technology to transmit data or control commands accurately and quickly between the monitoring end and the controlled end. In this paper, a wireless transmission through GSM network for Power Equipments Monitoring and Controlling system is implemented. The SMS scheme is used in the proposed transmission structure and shows a good performance in the real application. The presented devices for remote monitoring and controlling are tested under Taiwan Power Company with rather encouraging results. It shows the ability for future technique in wireless monitoring of power equipments.

5 Acknowledgment

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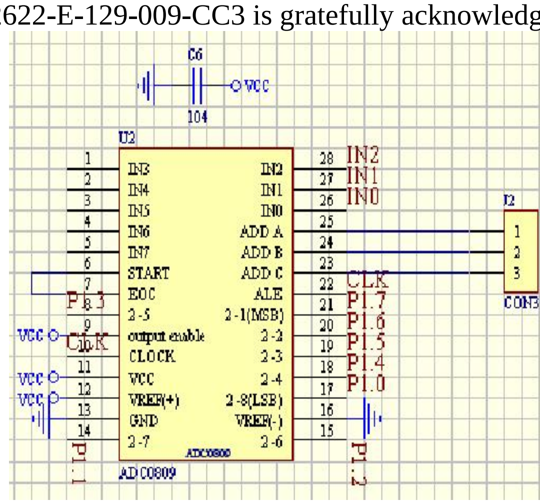

Fig. 6 Analog/digital conversion circuit

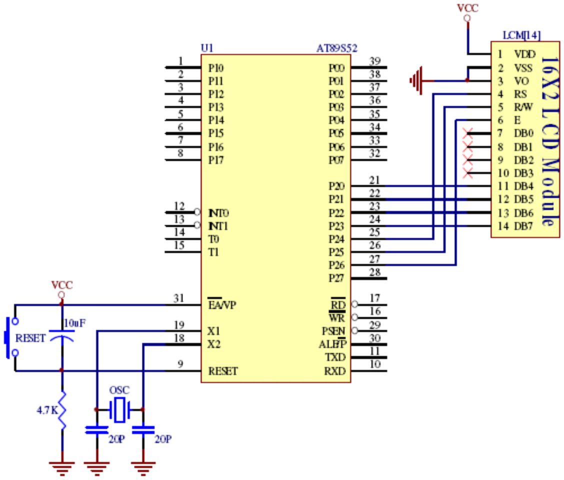

Fig. 7 LCM circuit

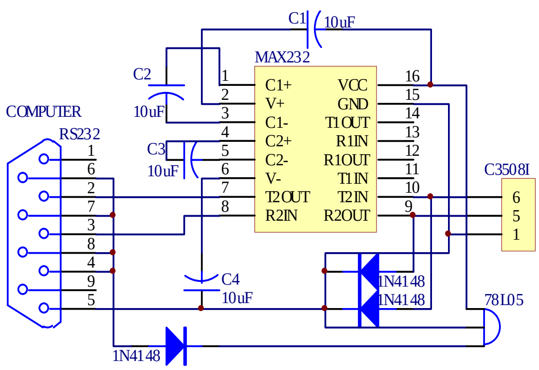

Fig. 8 Interface RS232 circuit

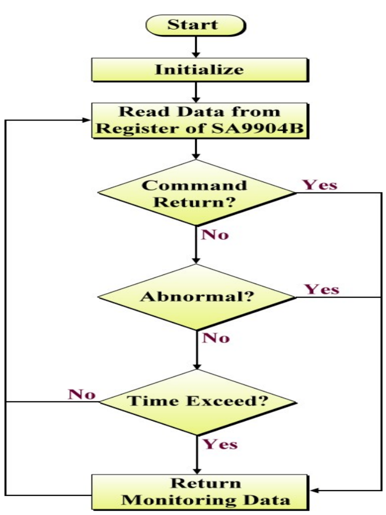

Fig. 9 System main flowchart

Fig. 10 Voltage and frequency displayed at the monitored end

Fig. 11 Active power and reactive power displayed at the monitored end

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